BS ISO 23239-1:2021

BSI Standards Publication

Road vehicles — Vehicle domain service (VDS)

Part 1: General information and use case definitions

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National foreword

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Part 1: General information and use case definitions

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared jointly by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 31, *Data communication*, in collaboration with ITU-T (as H.VDS-UC).

A list of all parts in the ISO 23239 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

The connected vehicles are expected to expand and become even more popular in the markets of different countries. A variety of technologies are being developed and discussed for many applications.

Everyone who drives a car collects traffic information to determine the correct driving behaviour and accurately recognize the relevant traffic information and driving conditions without delay. Although the autonomous driving function takes over the driver's operation, there is the same value in a judgment of correct driving behaviour. While many independent autonomous driving cars and intelligent driver assistance functions provide information collected by various sensors, LIDAR and radar, their performance is limited and the inaccuracies increase with ambient conditions such as weather and blind spots.

In addition, the blinkers normally equipped with all vehicles only provide one-way fragmentary information, though. If the vehicle communicates with other neighbouring vehicles or traffic participants and exchanges various information, it will be able to go beyond the limits of its sensor capabilities and blind spots to provide a more accurate assessment of the traffic situation. It will also be possible to negotiate planned driving manoeuvres with neighbouring vehicles and to coordinate the sequence and timing of driving manoeuvres.

This ability to share information between vehicles defined in this document is provided only on a direct communication network between the vehicle and neighbouring traffic participants. It will be accomplished with on-board functionality without investing in a significant communication infrastructure on the road. This will enable vehicles to make more accurate and appropriate driving choices, which will provide a number of benefits such as reducing traffic accidents and congestion with improving traffic efficiency.

An important aspect of this documentation development is focusing on implementation points throughout the vehicle. Typical use cases are collected, from which distinctive aspects of the implementation specification are derived. And beyond simple information exchange, the resulting information is reviewed, evaluated, and then used to generate reliable information that can be applied to critical vehicle controls.

The ISO 23239 series is developed within a unique standard number, so that it will eliminate inconsistencies and redundancies within the documentation. As a result of these tasks, compatibility and interoperability will be confirmed, being added the economy and efficiency of implementation with global consistency. Furthermore, by providing a concrete path from existing simple and partial communication interface to trusted vehicle implementation, it is expected to support a smooth launch of brand-new vehicle application and accelerate the introduction of next generation communication technologies into the future vehicle market.

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Road vehicles — Vehicle domain service (VDS) —

Part 1: General information and use case definitions

1 Scope

This document, as the first document in the ISO 23239 series, provides a basic definition of vehicle domain service and supplementary information on detailed concepts, as well as definitions of the typical and supplementary use cases being used to define the specification of applications.

Detailed specifications of communications and applications are provided in other documents in the ISO 23239 series, and they are not provided in this document.

NOTE The remote processes by the tools connected to the on-board diagnosis (OBD) connector in a vehicle, such as repair and maintenance, prognostics, monitoring, configuration and reprogramming of vehicle are out of the scope of this document.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1 Basis of vehicle domain

3.1.1
vehicle domain
VD
limited group of secure and reliable connections, provided by the *master vehicle* (3.2.2) and established on an existing network service by registering the *domain actor* (3.2.3)

Note 1 to entry: Vehicle domain is only related to network connection between master vehicle and domain actor. Physical or geometrical conditions are not included.

3.1.2
vehicle domain dynamic map
VDDM
dynamic map in the *vehicle domain* (3.1.1) generated by a *master vehicle* (3.2.2)

Note 1 to entry: VDDM consists of static high definition features, dynamic actors and other characteristics.

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3.1.3
vehicle-domain service
VDS
group of functions provided by the *master vehicle* (3.2.2) to the *domain actor* (3.2.3) in the *vehicle domain* (3.1.1)

Note 1 to entry: It includes *vehicle domain dynamic map* (3.1.2).

3.1.4
vehicle-domain service account
VDSA
unique identifier of the *domain actor* (3.2.3), certified and issued by the *vehicle domain service operator* (3.3.7)

3.1.5
vehicle-domain service master time
VDS master time
basic time steps for synchronization between the *master vehicle* (3.2.2) and the *domain actor* (3.2.3) generated by the master vehicle

Note 1 to entry: It generates both past and future time steps.

3.1.6
vehicle-domain service system
VDSS
physical structure that consists of the *master vehicle* (3.2.2) (server), neighbouring vehicles (client), other traffic participants (clients), and a wireless network between the server and its clients that provides vehicle domain service

Note 1 to entry: An element in the VDSS is named *primary actor* (3.2.1). Elements outside the *VDS* (3.1.3) are named *secondary actors* (3.3.1).

3.2 Primary actors

3.2.1
primary actor
PA
master vehicle (3.2.2) or one of its clients in the *vehicle domain* (3.1.1)

3.2.2
master vehicle
MV
server of *vehicle domain* (3.1.1)

Note 1 to entry: This means the vehicle in which the server function is implemented.

3.2.3
domain actor
DA
client of a *master vehicle* (3.2.2) in a *vehicle domain* (3.1.1)

Note 1 to entry: They are in general traffic participants, such as vehicles, bikes and walkers around the master vehicle.

3.2.4
domain vehicle
DV
vehicle client of a *master vehicle* (3.2.2) in a *vehicle domain* (3.1.1)

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3.2.5
domain participant
DP
client of a *master vehicle* (3.2.2) except for a vehicle in a *vehicle domain* (3.1.1)

EXAMPLE Walker, bike and other traffic participants with network function.

3.2.6
domain sensor
DS
client of a *master vehicle* (3.2.2) in a *vehicle domain* (3.1.1) with sensing function

Note 1 to entry: It is the network entity and typically, a vehicle with network and sensing function is often both a *domain vehicle* (3.2.4) and domain sensor at the same time.

Note 2 to entry: The general definition of a domain sensor never excludes the *domain actor* (3.2.3) except vehicle.

3.3 Secondary actors

3.3.1
secondary actor
SA
logical or functional network entity outside the *vehicle domain* (3.1.1)

3.3.2
smart-city traffic manager
SCTM
central management server of traffic information in a smart city

3.3.3
smart traffic
optimized traffic controlled by the *smart city traffic manager* (3.3.2) in a smart city

3.3.4
smart traffic architecture model proposal
STAMP
model proposal of the multi-layer-like control structure of *smart traffic* (3.3.3)

3.3.5
traffic operator
TO
lower functional server of the *smart city traffic manager* (3.3.2) that manages traffic control information

3.3.6
traffic monitor
TM
lower functional server of the *smart city traffic manager* (3.3.2) that monitors traffic status

3.3.7
vehicle domain service operator
VDSO
service operator who issues the *vehicle-domain service account* (3.1.4)

4 Abbreviated terms

For the purpose of this document, the following abbreviated terms apply:

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BUC	business use case
DSRC	dedicated short range communication
IP	internet protocol
LDM	local dynamic map
NTP	network time protocol
STAMP	smart traffic architecture model proposal
SUC	system use case
TCP	transmission control protocol
TLS	transport layer security
UTC	universal time

5 Conventions

5.1 Documents overview on OSI based services.

Figure 1 shows the organization and coverage of each of the documents in the ISO 23239 series on the OSI layered architecture.

The definition of OSI layer model is defined in ISO/IEC 7498-1.

As indicated by the bold framed shapes, this document defines general information and use case definitions. This is the base document, as the other documents in the ISO 23239 series are detailed and separated specific documents according to the OSI layered architecture.

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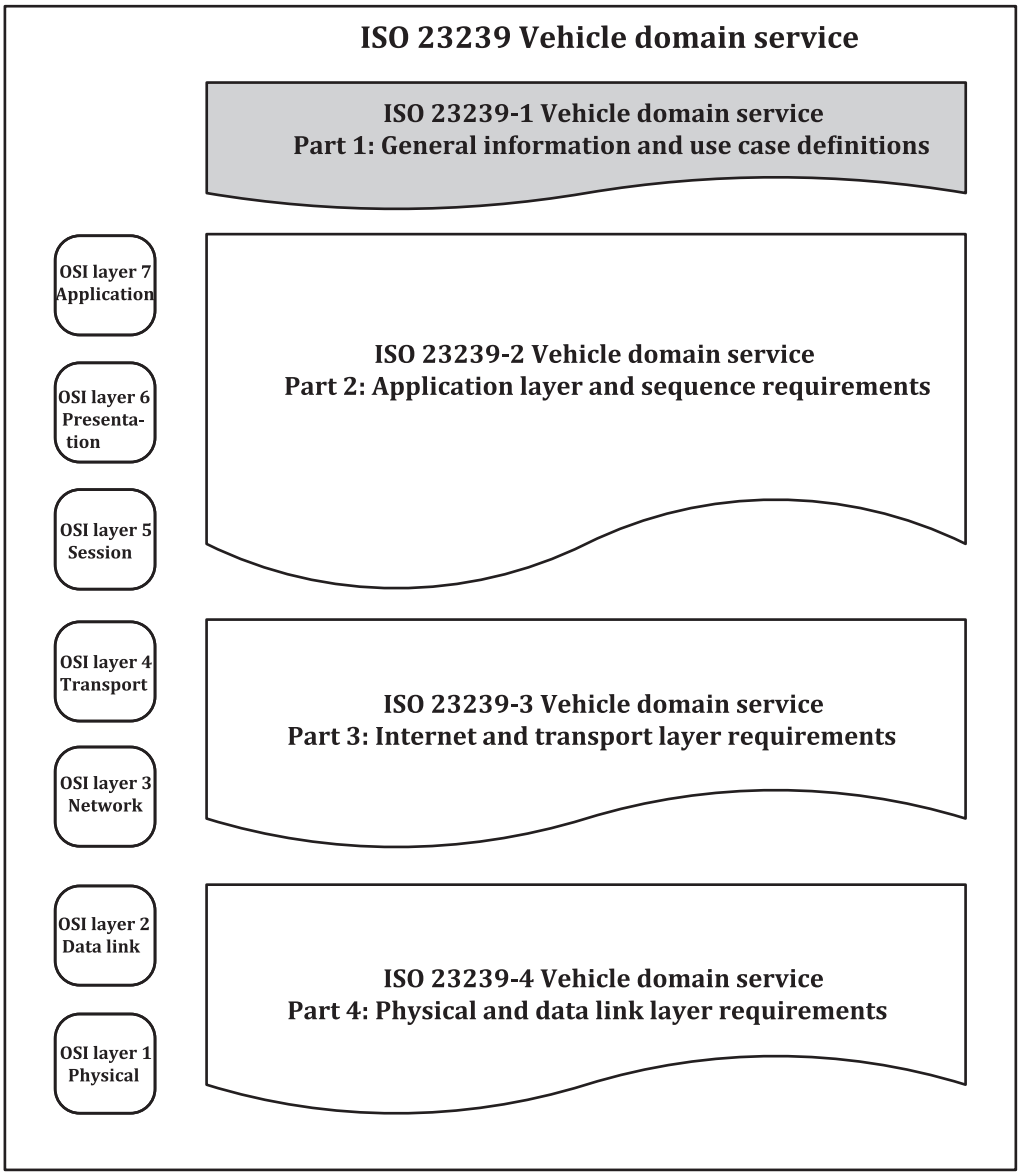

Key

Coverages

description coverage of this document

description coverages of other parts of ISO 23239 series

Figure 1 — Documents overview of vehicle domain service

The upper layers are not fit for proper TCP/IP communication.

5.2 General policy structure

This document provides the policies for specifications as general information. The list of the policies consists of recommendation, permission, possibility and capability. Additional statements are attached in order to provide better understandings. All policies are expressed in a unified format.

This document applies a policy structure, i.e. a unique number identifies each individual policy included in this document. It will improve the readability with easier policy tracking. The following modified recommended format will be applied:

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'VDS''Y' - 'xxx' — policy name
[
policy text
]

where

— '**VDS**' represents the ISO 23239 series,

— '**Y**' represents the specific part of the ISO 23239 series,

— '**xxx**' represents the individual policy number,

— '**policy name**' represents the name of policy,

— 'policy text' defines the provisions of policy and

— '**[**' and '**]**' defines the starting and ending points of policy.

EXAMPLE

VDS1 - 000 — The form of general policy
[
This sentence should give the example form of the general policy defined in this document.
]

6 General information for vehicle domain service

6.1 General

The vehicle domain is the area that consists of road vehicles in which the applications are implemented. The applications provide integrated information services used in the vehicle. The provided information is generated from various source information, acquired by the communication, concerned with the area around the vehicle such as traffic condition and so on. The source information is acquired directly or indirectly by communication with neighbouring vehicles and other traffic participants (bikes, bicycles and walkers) without any support by the road sided infrastructure.

This clause gives the basic definitions of vehicle domain services.

6.2 Vehicle domain service

The master vehicle generates a vehicle-domain network. Surrounding participants, such as vehicles, bikes and walkers, join that network as domain actors. Various types of sensors equipped with participants could also join it as additional actors. The master vehicle provides vehicle domain services to the actors participating in its domain service network.

VDS1 - 001 — Vehicle domain service
[
If a vehicle is the master vehicle of the vehicle domain, it should provide vehicle domain services to the domain actors.
]

Figure 2 shows a basic vehicle domain service. The master vehicle communicates with domain actors, such as domain vehicles, sensors and participants. The master vehicle provides vehicle domain services and domain actors respond to them.

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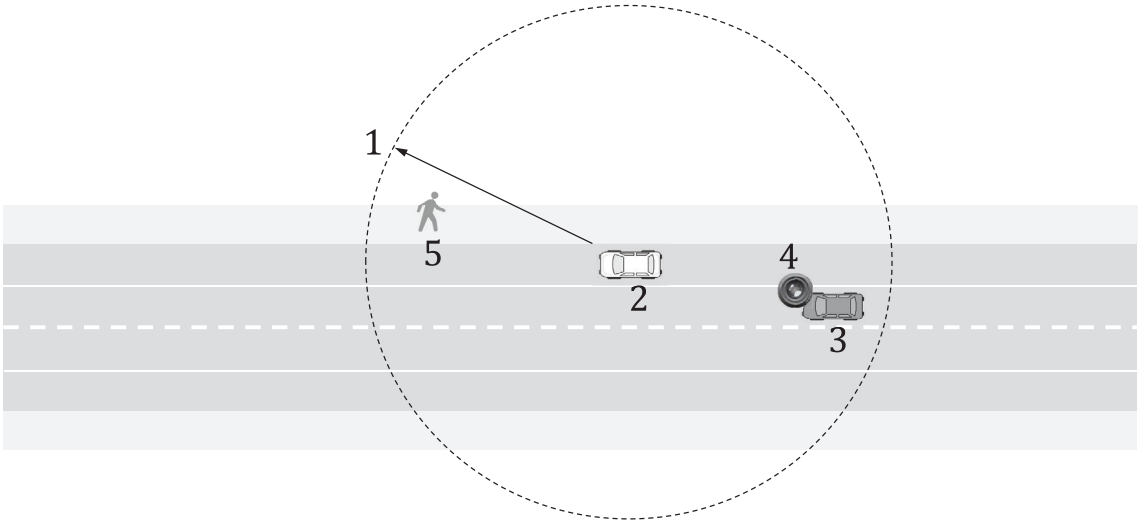

Key

1 vehicle domain
2 master vehicle
3 domain vehicle
4 domain sensor
5 domain participant

Figure 2 — Basic vehicle domain service

The minimum structure of the vehicle domain service consists of one master vehicle and one domain actor. The field in which the vehicle domain is located includes everywhere the vehicle goes, such as traffic roads, public parking areas and private garages.

VDS implementation depends on the original equipment manufacturer's (OEM) decision. Activation of implemented VDS function depends on user's or owner's decision, local regulation or other rules before driving.

6.3 Vehicle domain dynamic map service

The most typical service of VDS is the vehicle domain dynamic map service. The VDDM is the beginning, original and most important service of VDS. It is applied to the vehicle driving with no restriction of location, i.e. on the road, street, freeway, public parking area and private road.

The master vehicle collects relevant information from all of domain actors. The domain sensors report acquired information about silent traffic participants and conditions instead of them. The master vehicle generates dynamic map information within the vehicle domain. The master vehicle provides VDDM-based services to the domain actors.

VDS1 - 002 — Vehicle domain dynamic map service
[
The master vehicle should provide vehicle domain dynamic map services to the domain actors.
]

Figure 3 shows a typical vehicle domain dynamic map service. The master vehicle communicates with the domain actors, such as domain vehicles, sensors and participants. The master vehicle provides vehicle domain dynamic map services and the domain actors respond to them.

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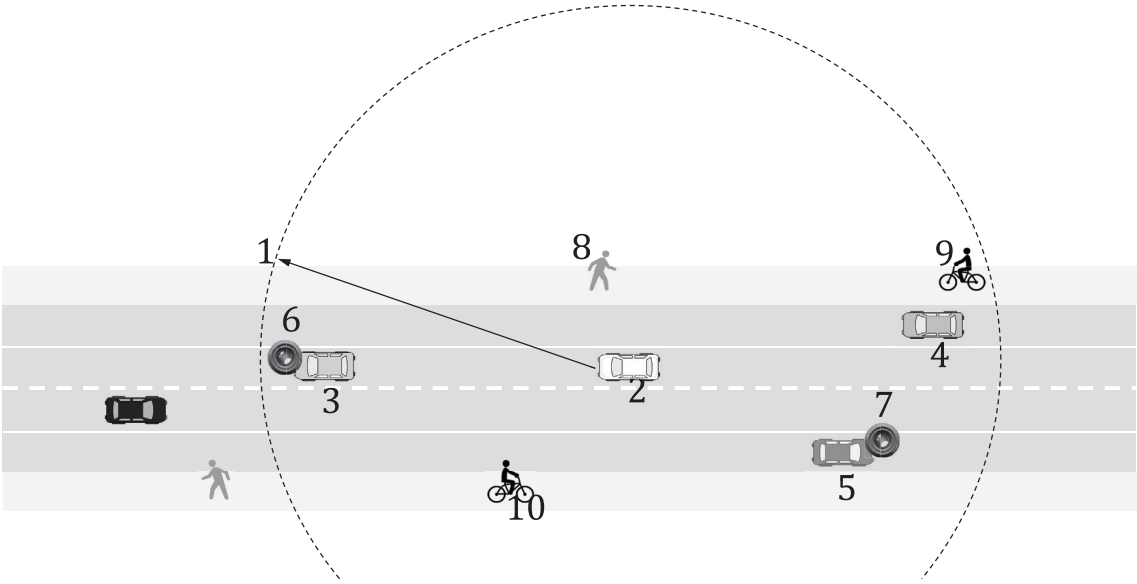

Key

1 vehicle domain
2 master vehicle
3 domain vehicle 1
4 domain vehicle 2
5 domain vehicle 3
6 domain sensor 1
7 domain sensor 2
8 domain participant 1
9 domain participant 2
10 domain participant 3

Figure 3 — Typical vehicle domain dynamic map service

6.4 Variations of vehicle domain services

6.4.1 Basic functions of vehicle domain service

The basic functions of VDS are collecting and processing traffic and driving information. Generated information services are used to get better recognition of traffic situations and improve decision of driving behaviour.

These kinds of generated information provided in a virtual map format consist of information about dynamic actors, such as vehicles and participants, and static high definition road features. This is defined as a vehicle domain dynamic map.

To perform various functions, VDS has multiple services.

Below are the typical services of VDS.

— Vehicle domain registration: the master vehicle calls the domain actors to participate in its domain. A domain actor will respond to the master vehicle and exchange credentials. If mutual identification processes are successfully completed, a secure connection shared by the master vehicle and the domain actor is generated.

— Traffic explorer: the master vehicle collects traffic information by communicating with the domain actors. The traffic information collected is the synchronized position and other information of the

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domain actors around the master vehicle or information potentially related to the driving behaviour of the master vehicle.

— Traffic reporter: the master vehicle reports the collected local traffic information, obtained by the traffic explorer service, to the other traffic servers, such as central dynamic map operator or another vehicle domain server. It will be shared to update the latest status and it can be reused in a similar use case of another master vehicle.

— Manoeuvre coordinator: the master vehicle generates its driving manoeuvre plan, it consists of a series of position information with synchronization time. The master vehicle sends it to the relevant domain vehicle and asks the corresponding plan of the domain vehicle. The master vehicle and domain vehicle share their driving manoeuvre plan to get an agreement or negotiate the coexistence of their plans. If it is successfully done, planned driving manoeuvre will be performed safely under the shared understandings of them.

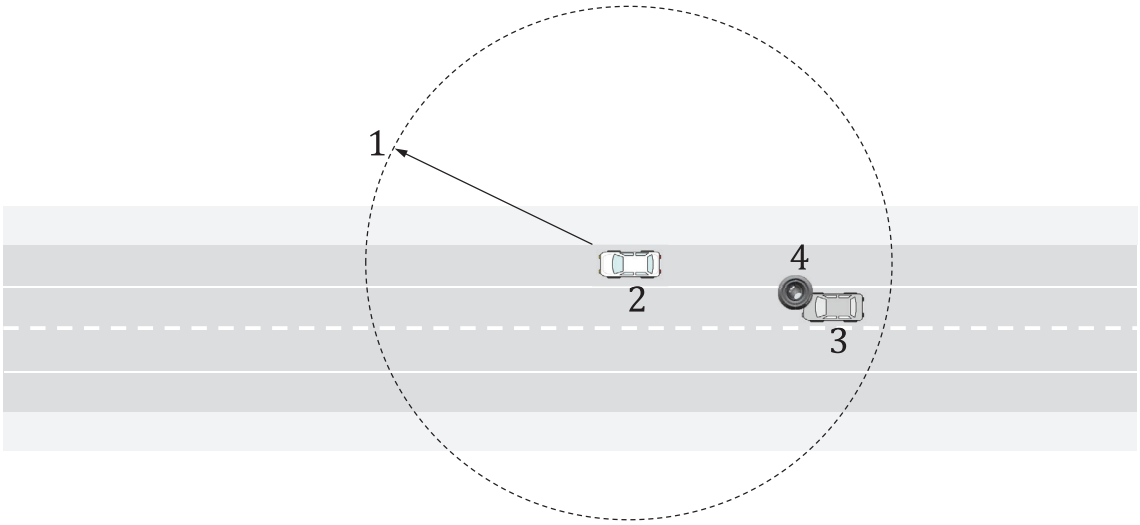
6.4.2 Vehicle domain registration service

The master vehicle provides the following vehicle domain services.

VDS1 - 003 — Vehicle domain registration service
[
The master vehicle should support the vehicle domain registration service.
]

Figure 4 shows a typical vehicle domain registration service. The master vehicle calls neighbouring vehicles and traffic participants to join the vehicle domain. For example, the vehicle in the rear position is able to join the invited vehicle domain by performing the registration. If the registration is performed successfully, the vehicle in the rear position will join the vehicle domain as a domain vehicle. Details of procedures will be provided in the subsequent parts of the ISO 23239 series.

In case that the entity of sensor is also registered, it will join the vehicle domain as a domain sensor.



Key

1 vehicle domain
2 master vehicle
3 domain vehicle
4 domain sensor

Figure 4 — Typical vehicle domain registration service

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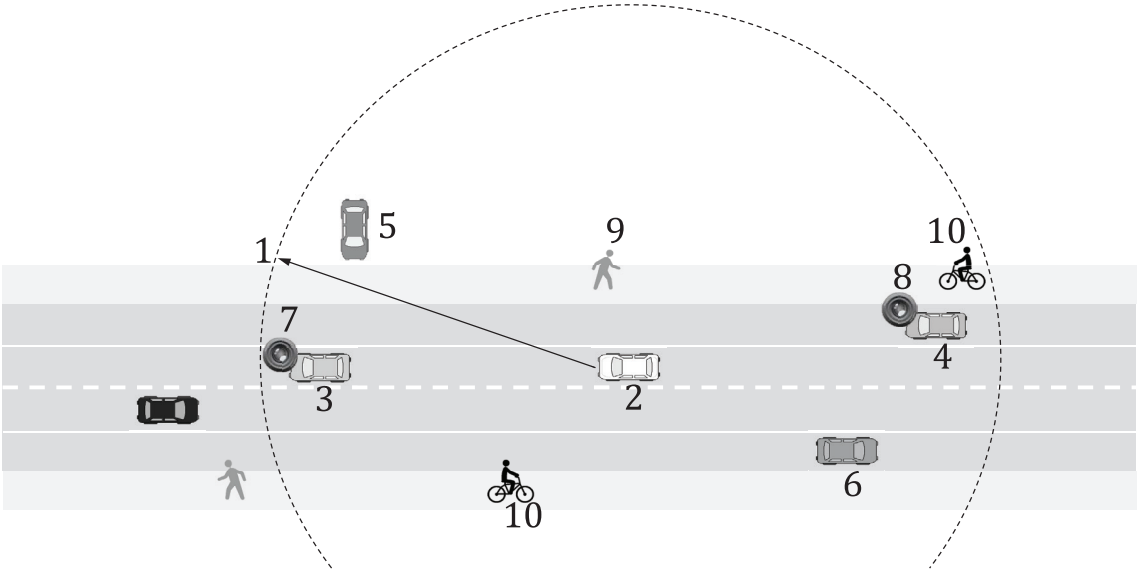
The vehicle domain has the driving plan of the master vehicle. The driving plan is a kind of driving schedule with a longer period than a driving manoeuvre, such as 'turn right at the intersection 1 km away'. If the driving plan of a domain vehicle is different from that of the vehicle domain, the domain vehicle will exit from the vehicle domain and generate its own vehicle domain.

6.4.3 Traffic explorer service

The master vehicle provides the following vehicle domain service.

VDS1 - 004 — Traffic explorer service
[
The master vehicle should support the traffic explorer service.
]

Figure 5 shows a typical traffic explorer service. The master vehicle asks the domain actors for specific parameters (type, dimensions) and measured parameters (position, speed) calibrated with VDS master time. The domain actor responds to it with synchronized information. The master vehicle will create a vehicle domain map.



Key

1 vehicle domain
2 master vehicle
3 domain vehicle 1
4 domain vehicle 2
5 domain vehicle 3
6 domain vehicle 4
7 domain sensor 1
8 domain sensor 2
9 domain participant 1
10 domain participant 2
11 domain participant 3

Figure 5 — Typical traffic explorer service

In order to generate a VDDM, the master vehicle asks each domain actor to provide a list of its properties. All property tables with the responses to the master vehicle are required to be synchronized to the domain master time provided by the master vehicle.

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As the one of important procedure of VDDM generation, it is necessary that collected properties are validated by each other. If validation is completed successfully, the property status changes to trustable.

VDS1 - 005 — Validation of vehicle domain map
[
The master vehicle should validate vehicle domain map to be trusted.
]

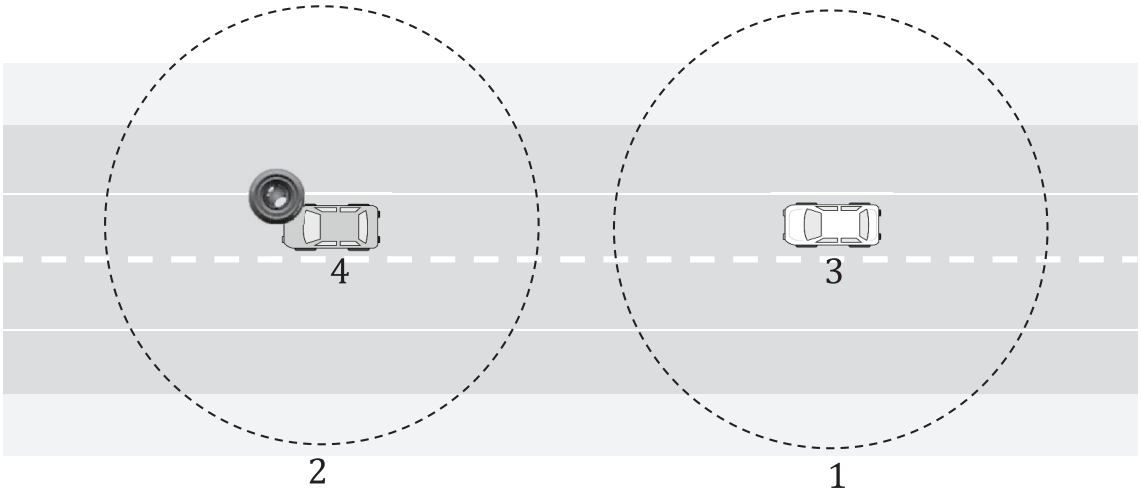
More detailed procedures will be provided in the following series part of this document.

6.4.4 Traffic reporter service

The master vehicle provides following vehicle domain service.

VDS1 - 006 — Traffic reporter service
[
The master vehicle should support the traffic reporter service.
]

Figure 6 shows a typical traffic reporter service. There are multiple master vehicles driving on the road. Master vehicles create their VDS maps information. They report some part of VDS maps to other master vehicles if foresight information is included. Additionally, they also send the created map report to the central LDM server for the latest map update.



Key

1 vehicle domain 1
2 vehicle domain 2
3 master vehicle 1
4 master vehicle 2

Figure 6 — Typical traffic reporter service

Before master vehicle 1 builds up vehicle domain 1, it will search for neighbouring vehicle domains. Master vehicle 1 finds vehicle domain 2 and its driving plan matches that of master vehicle 1; master vehicle 1 will join vehicle domain 2. If driving plan is different and it is better to establish vehicle domain 1, master vehicle 1 will establish vehicle domain 1 with a different driving plan from vehicle domain 2. Details of sequences will be defined in subsequent parts of the ISO 23239 series.

Basically, traffic reporter service has valid direction and an area for the receiver of the vehicle domain. The master vehicle and domain actors within the vehicle domain are driving forward and never encounter the incident that happened at the back of the vehicle domain. Also, other vehicle domains

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driving in the opposite direction on the opposite lane will be invalid to receive the traffic reporter service.

Vehicle domain service exchanges a lot of messages, giving restrictions to the communication media access to valid information will have a significant effect on the efficiency of communication.

VDS1 - 007 — Selected media access of vehicle domain service
[
The vehicle domain service should be transmitted only to valid receivers.
]

One of the typical schemas for selected access are filtering access control. A couple of schemas will be prepared for vehicle domain service message exchange. More detailed procedures will be provided in the following series part of this document.

NOTE There exists no contradiction between extended vehicle and traffic reporter of vehicle domain service. V2X solutions could exist in many ways depending on each markets' requirements.

6.4.5 Manoeuvre coordinator service

The master vehicle provides following vehicle domain service.

VDS1 - 008 — Manoeuvre coordinator service
[
The master vehicle should support the manoeuvre coordinator service.
]

Figure 7 shows a typical manoeuvre coordinator service. The master vehicle generates its manoeuvre plan with the VDS master time. Domain vehicles respond to it with the synchronized estimated information.

In general, the typical driving processes consists of the recognition, decision and operation stages. Recognition of the traffic situation and making the most appropriate and safest driving decisions will be named as the preparation stage. For example, if preparation stage takes 5 s and the following operation stage takes the same time, the master vehicle will generate its driving manoeuvre plan starting from its position of 5 s later, end of preparation stage with following positions of 1 s durations, expressed in Figure 7 with sequential blue dot squares. Master vehicle will ask the following domain vehicle about its relevant manoeuvre plan. The domain vehicle will respond with the asked driving manoeuvre plan expressed with sequential red dot squares. The starting time of each driving manoeuvre plan or turn of them will be adjusted, if necessary.

Whole processes about driving manoeuvre negotiation are necessary to be successfully finished within preparation stage. This indicates that the VDS includes this service and will be implemented with the next generation of communication technology with faster speed, wider traffic bands and lower latency. The VDS communication is definitely different from existing broadcast message flow.

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